

## TRAINING WITH FAST FEEDBACK ON A MEASURING UNIT IN SPRINGBOARD DIVING

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The purpose of the study was to determine effects of visual feedback presented by a complex measuring unit. Feedback pictures for the diver were selected for defined events because of the synchronized data from force measuring and the board inclination. With these images of the diver and an added reference picture (model stick-figure) the differences between the model and the actual performance were shown to the athletes. Fifteen divers took part in six sessions (each with six dives backwards and separated by one week) and got visual feedback within four sessions. Analysis of the dive height and of the differences between the divers' actual performance and the model performance show there are no differences between the first and the last session. Results supported, that four feedback training sessions are not enough to change the movement of the divers.

**KEYWORDS:** springboard diving, measuring unit, feedback training, motor learning

**INTRODUCTION:** Important indicators of performance in springboard diving are dive height and angular momentum. To maximize the height and optimize the angular momentum the takeoff phase is important. Especially in springboard diving (in contrast to platform diving) the interaction between diver and board is hard to understand and difficult to learn for the divers. To get more information about the board-diver-interaction researchers use models to investigate effects of different diver performances (Kong, Yeadon & King, 2004; Cheng & Hubbard, 2004; Sprigings & Miller, 2004). These results and much experience from diving coaches were used to inform divers about optimization of their technique. There is a lack of publications about feedback for divers to improve their performance (one example: Slobounov, 1996). Own investigations were focussed on the flight phase of the dive. In this context we used the "Somersault Simulator" to prepare young divers for a new task or optimize known tasks. The divers should improve leaving from the tucked into the straight position for a correct water entry (Naundorf, Krug & Latke, 2004). After performing their task the athletes could see static images of dynamic motion with reference images (model performance). With this image criterion-actual value discrepancies were presented. Athletes were able to identify if their own position was too late, correct or too early. The same idea was realized for the takeoff phase, using a measuring unit (see figure 1) with video system and measuring springboard (Naundorf & Knoll, 2004). The study was designed to demonstrate effects of feedback in diving training.

**METHODS:** The measuring springboard with the possibility to measure horizontal and vertical forces was used. To calculate these force data correct it is important to know the angle of the measuring plane. Using a computer based video system (50 frames per second) the board's angle of inclination could be measured automatically within seconds. After locating two markers of the springboard in the first picture, the video system tracks the markers during the board movement itself. This was a requirement for a feedback system, to inform the athletes after a short interval about their performance. After recording and calibration the forces a transformation of these parameters to the horizontal plane by using the synchronized data from the board's angle of inclination is necessary (Naundorf &

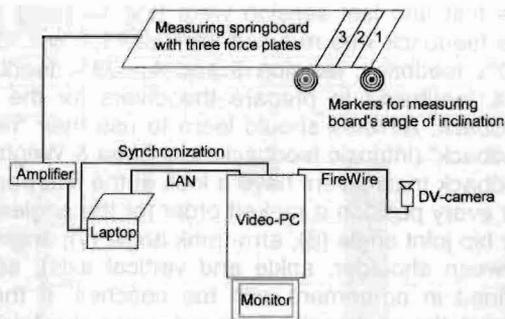
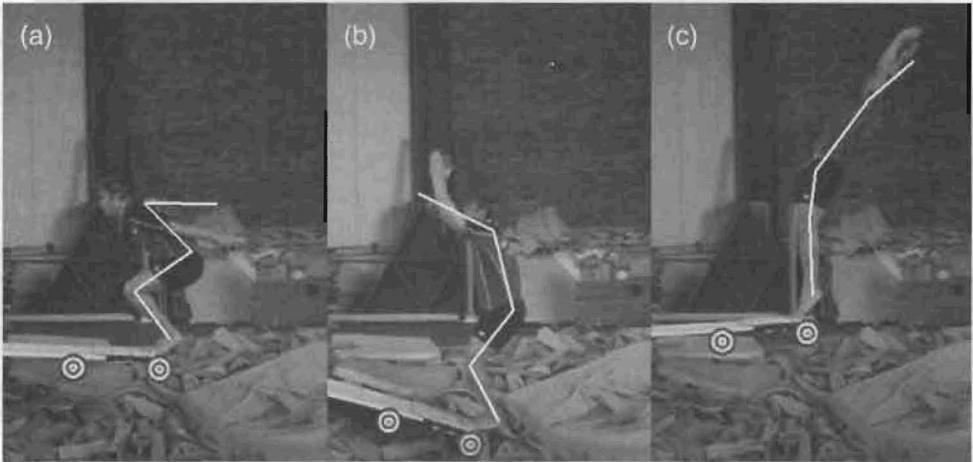


Figure 1 Measuring unit for springboard diving.

Knoll, 2004). By using the data from the board depression and the transformed forces, previously defined events were identified. In our first investigation with backward dives (from standing position) these events were:

- 1) board's angle of inclination with diver's weight,
- 2) maximum angle of inclination (maximum board depression) and
- 3) takeoff (last contact of the diver with the board).

This will be in agreement with the coaches. For every event the feedback software adds a special stick figure showing the optimal performance for the event to the picture. This stick figure focus the attention of the athletes on the model performance. After their performance the athletes could have a look at these pictures (see Figure 2) and get the differences between the model and the actual performance.

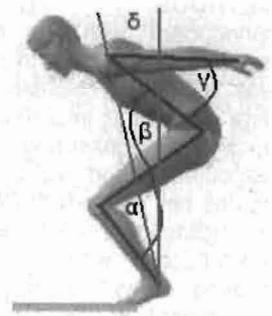


**Figure 2** Feedback pictures for the diver left (a): board's angle of inclination with diver's weight, middle (b): maximum angle of inclination and right (c): takeoff.

Fifteen youth competitive divers (5 male and 10 female; age M: 12.02 years SD 1.31) participate. Following training protocol was used:

- six backward dives per training unit,
- six training units,
- each unit was separated by one week.

The first and last session were test sessions without feedback. The feedback was reduced from session two to five (session 2 - 100% feedback, session 3 and 4 - 75% feedback, session 5 - 50% feedback) to prepare the divers for the sessions without feedback. Athletes should learn to use their "response-produces feedback" (intrinsic feedback, see Shea & Wright, 1997). After the feedback trials divers have a look at the first position, first picture. For every position a ranked order for the angles (knee joint angle ( $\alpha$ ); hip joint angle ( $\beta$ ); arm-trunk angle ( $\gamma$ ); angle of lean ( $\delta$ , angle between shoulder, ankle and vertical axis), see Figure 3) was defined in agreement with the coaches. If the first angle was correct, the next angle of the order was checked. If this angle was not correct, divers get the information about this angle and a correction ("bend your knee joint"). Such a procedure to inform learners only about the first wrong aspect of ordered movement details was used by Kernodle & Carlton (1992) for a throwing task.



**Figure 3** Definition of the angles.

After having a look at all three pictures divers got three cues (one for every position).

All backward dives from the sessions without feedback were analysed. The angles (knee joint angle -  $\alpha$ ; hip joint angle -  $\beta$ ; arm-trunk angle -  $\gamma$ ; angle of lean -  $\delta$  (angle between shoulder, ankle and vertical axis), see Figure 3) and the dive height were measured. For the angles the discrepancies between model (set angle) and actual performance were calculated, by using the total variability error (E, see Schmidt & Lee, 1999, equation 1). This is a measure for the subject's accuracy and variability or inconsistency. The dive height was also calculated, using the center of mass. For statistical analysis the software package SPSS 11.0 was used. To prove differences for the angle measures the Wilcoxon sign-rank test was used because data are not normally distributed. We are using the t-Test to compare two measures for the dive height.

$$E = \sqrt{\frac{1}{n} \sum (x_i - T)^2} \quad (1) \quad \text{where: } x_i - \text{angle } (\alpha, \beta, \gamma, \delta) \text{ of the diver;}$$

$T$  – set angle (target angle);  $n$  – Number of dives

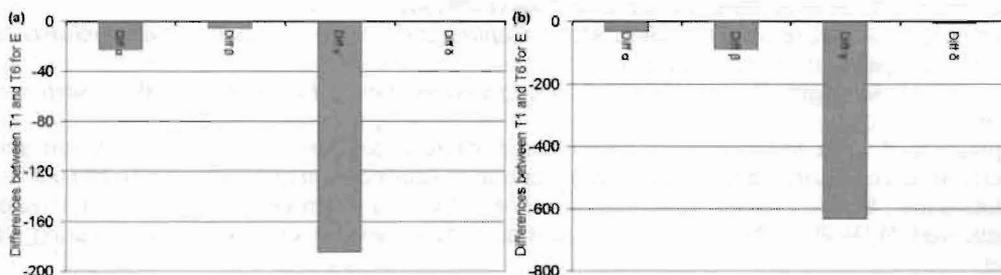
**RESULTS AND DISCUSSION:** The tests failed to find significant differences (see Table 1) between the two measures. Results of the first and the last session are displayed in the tables 1 (angles), and 2 (dive height).

**Table 1 Results for the three feedback positions.**

Angle	MD Session 1 (first)	MD Session 6 (last)	Z	p
Position (a), board's angle of inclination with diver's weight				
E for knee joint angle ( $\alpha$ )	9,64°	6,46°	-0,284	.388
E for hip joint angle ( $\beta$ )	21,85°	23,42°	-0,568	.258
E for arm-trunk angle ( $\gamma$ )	42,46°	60,80°	-1,079	.141
E for angle of lean ( $\delta$ )	6,85°	5,94°	-0,909	.182
Position (b), maximum angle of inclination				
E for knee joint angle ( $\alpha$ )	16,23°	15,65°	-0,170	.433
E for hip joint angle ( $\beta$ )	27,36°	45,38°	-1,477	.070
E for arm-trunk angle ( $\gamma$ )	129,64°	190,90°	-1,250	.106
E for angle of lean ( $\delta$ )	8,32°	7,72°	-0,284	.388
Position (c), takeoff				
E for knee joint angle ( $\alpha$ )	31,32°	35,28°	-1,022	.154
E for hip joint angle ( $\beta$ )	21,75°	26,98°	-0,625	.266
E for arm-trunk angle ( $\gamma$ )	53,98°	44,11°	-0,170	.433
E for angle of lean ( $\delta$ )	9,30°	13,67°	-0,852	.197

**Table 2 Results for the dive height.**

	Mean Session 1 (first)	Mean Session 6 (last)	T	p
Dive height	0,462 m	0,456 m	0,472	.322



**Figure 4 Individual analysis of E, differences between session 1 and 6 for first (a) and second (b) feedback position.**

But single athlete analysis indicate an increase in performance. Improvement in the dive height (from 0.55m to 0.61m) based on decreasing E especially for the first two positions (see Figure 4). Only for the takeoff-position there were no major changes of the angles. At this position the athletes show the lowest E and there is only less potential for a better performance. The main effects for the positions are at the arm-trunk angle ( $\gamma$ ). This angle has the largest potential amplitude. This example shows that the results of the whole group hide individual effects.

For further investigations there are two possibilities for increasing group effects:

- 1) To have a greater impact on diving performance more training sessions (for instance two sessions per week) with feedback training are necessary.
- 2) Without more feedback training with the measuring unit there is the possibility to use the cues not only for the feedback sessions, but also for the "normal" diving training (dry land training and dives into the water). Coaches should focus their attention in their training sessions on the individual mistakes detected in the feedback sessions on the measuring unit. A better coordination between diving training and the special feedback training is a potential for increasing diving performance.

**CONCLUSION:** In all we can report, there is no modification of the average performance of the divers within six training sessions, each with six dives (total 36 dives, but only 24 dives in feedback sessions). However, single athlete analysis showed some positive effects. In addition a more detailed look at the diving training, the training on the measuring unit (one session about 20 minutes) is only about 2 percent of the whole training time. Counting the backward dives into the water per week for the training sessions in the pool, the dives on the measuring units are about 13 percent.

Ongoing training sessions focus on reverse and forward (with running approach) dives.

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